Claim 9. A process for producing low-molecular olefins by thermal pyrolysis of hydrocarbons said process comprises steps:

a) preparation of evaporated feedstock steam mixture, **(1)**

"This process comprises the following stages: preheating and evaporating a starting feedstock; mixing the same with a steam-diluent..." (page 5, line 10)

"Preheating a feedstock and steam-diluent in the first stage is carried out in the preheater 1. The hydrocarbon feed from outside source (not shown in drawings) is conveyed by pressure into the preheater 1 configured as a shell-tube heat exchanger. The exhaust gas from the gas-turbine engine 5 is discharged into intertubular space of this heat exchanger. From outside source (not shown in drawings) a water is conveyed by pressure into the preheater 1 where the water is evaporated, and resulting steam-diluent is mixed with the hydrocarbon feed." (page 6, lines 27 – 32)

"... which comprises preheating and evaporating a starting feedstock, mixing the same with a steam-diluent,..." (page 13, lines 5 – 6)

"... mixing the same with steam-diluent,..." (page 14, lines 3 – 4)

b) preheating the resulting mixture **(2)**

"Preheating a feedstock and steam-diluent in the first stage is carried out in the preheater 1. The hydrocarbon feed from outside source (not shown in drawings) is conveyed by pressure into the preheater 1 configured as a shell-tube heat exchanger. The exhaust gas from the gas-turbine engine 5 is discharged into intertubular space of this heat exchanger. From outside source (not shown in drawings) a water is conveyed by pressure into the preheater 1 where the water is evaporated, and resulting steam-diluent is mixed with the hydrocarbon feed.

Preheating a feedstock and steam-diluent in the second stage is carried out in the apparatuses 2 and 3 for quenching cracked gas by utilisation of heat of cracked gas leaving the reactor." (page 6, lines 27 – 35)

"The amount of water being mixed with hydrocarbon feed and tolerance final temperature depend on composition of feedstock. If a feedstock is the ordinary gaseous hydrocarbons, the amount of added water may be to 30-40% in ratio to hydrocarbon weight rate, and the temperature of reacting mixture after second preheating should not exceed 650°C. If the ordinary liquid hydrocarbons - such as naphtha or gas oils - are used as a feedstock, the water may be added in amount to 80-100% in ratio to hydrocarbon weight rate, and relevant temperature of reacting mixture after second preheating should not exceed 550-600°C." (page 7, lines 19 – 25)

c) heating said mixture up to pyrolysis temperature, **(3)**

"Heating the reacting mixture to pyrolysis temperature is performed by mixing it with the hot pyrolized gas for the negligible time in comparison with a duration of pyrolysis reactions." (page 7, lines 4 – 6)

"The period of time for heating the incoming feed/steam mixture from the temperature when entering into the reactor up to pyrolysis temperature is defined by duration of mixing with reacting mixture being processed and does not exceed 0.001 sec. It is negligible short time in comparison with the residence time of reacting mixture within a working space of the reactor." (page 8, lines 8 – 12)

d) a supply with a heat, which is necessary for pyrolysis, into the process stream, **(4)**

" ...the heat needed for pyrolysis is generated directly inside the volume of reacting mixture due to hydrodynamic drag effect of rotating working wheel provided with the blades." (page 7, lines 2 – 4)

"The set temperature is maintained by automatic control system regulating a rate of fuel gas feeding the

gas-turbine engine. So the temperature in the reaction zone of the reactor is regulated as in principle as it is done in the traditional tubular furnace - by changing a rate of fuel gas in ratio to a rate of feedstock." (page 8, lines 23 – 26)

"Thus two communicating loops of pyrolized gas recirculation are created. A heat being absorbed by endothermic reactions, which continuously proceed within the reactor working space, is compensated by influx of heat arose from converting kinetic energy into heat." (page 10, lines 8 – 11)

"During every passing over the working blade the reacting fluid acquires an additional kinetic energy, which for the time before next passing is converted into a heat. This occurs partly due to passing the fluid through stationary compression shocks arising in places of local transition of the fluid through sonic barrier, and partly due to vortex formation. The additional kinetic energy is proportional to product of the rotor peripheral velocity and meridional velocity of the fluid. For example, at the rotor peripheral velocity 300-400 m/s this energy can be about 70-150 kJ/kg. During the time of residence within recirculation loop every particle of feedstock should pass over the rotor working blades several tens times on average." (page 10, lines 20 – 27)

e) quenching a product stream, and (5)

"… quenching a cracked gas…" (page 5, line 13)

"The cracked gas from the reactor 4 is conveyed into the quenching apparatuses 2 and 3 through interconnecting pipes having smooth shape to prevent formation of flow detachment zones. All these interconnecting pipes are equalised in volume.

The cracked gas is quenched in the apparatuses 2 and 3 and then transported into a gas fractionating plant (not shown in the drawings). In the Fig. 1 there are depicted two apparatuses for quenching cracked gas, but the number of this apparatus is not limited in the invention practical realisation." (page 7, lines 8 – 14)

"… quenching a cracked gas…" (page 13, line 8; page 14, line 6)

f) fractionation of the product stream, wherein (6)

"… subsequent separation of it…" (page 5, line 13)

"The cracked gas is quenched in the apparatuses 2 and 3 and then transported into a gas fractionating plant (not shown in the drawings)." (page 7, lines 11 – 12)

in the step a) amount of added steam-diluent per mass of hydrocarbon feedstock does not exceed the limits accepted in existing pyrolysis plants, (7)

"…an amount of added steam-diluent per weight of hydrocarbon feed does not exceed the regulation limits accepted in existing pyrolysis plants." (page 5, lines 6 – 7)

"The amount of water being mixed with hydrocarbon feed … depend on composition of feedstock. If a feedstock is the ordinary gaseous hydrocarbons, the amount of added water may be to 30-40% in ratio to hydrocarbon weight rate, … If the ordinary liquid hydrocarbons - such as naphtha or gas oils - are used as a feedstock, the water may be added in amount to 80-100% in ratio to hydrocarbon weight rate, …" (page 7, lines 19 – 25)

steps c) and d) are performed in a reactor, comprising: a hollow housing having a nipple for inlet stream, and a nipple for outlet stream, and stationary blades; (8)

"This reactor comprises a housing provided with directing stationary blades, an inlet nipple for supplying feedstock, an outlet nipple for carrying off cracked gas…" (page 5, lines 28 – 29)

"A reactor for pyrolysis of hydrocarbons comprising a housing with directing stationary blades, an inlet nipple for supplying feedstock, an outlet nipple for carrying off cracked gas…" (page 13, lines 16 – 18)

a rotatable wheel with a work blades is positioned in said housing so that said wheel with said housing together form an annular work cavity, **(9)**

"The housing has an annular cavity for recirculation of hot pyrolized gas, where the directing stationary blades are located. This cavity surrounds the blade crown of the working wheel on periphery…" (page 5, lines 30 – 32)

"… the said housing has an annular cavity for recirculation of hot pyrolized gas, which contains the directing stationary blades and surrounds the blade crown of the working wheel along periphery…" (page 13, lines 19 – 21)

See Fig. 2 and Fig. 3

said cavity is formed so and said stationary blades and work blades are positioned in said cavity and are shaped to create a ring vortex flow in said cavity when said wheel is rotated, and **(10)**

"…the annular working cavity where the working blades 25 and the directing blades 17, 18, 19, 20 are arranged. Processed fluid being recirculated along the annular cavity comes into multiple contacts in turn with the stationary directing blades and rotating working blades, thereby creating streamlines in the form of two spirals rolled up into vortex rings of right and left directions..Thus two communicating loops of pyrolized gas recirculation are created." (page 10, lines 4 – 9)

said nipple for inlet stream and said nipple for outlet stream are communicated with said work cavity, **(11)**

"… the inlet and outlet nipples are communicated with the said cavity." (page 5, lines 32 – 33)

"…the said inlet nipple for supplying feedstock and outlet nipple for carrying off cracked gas are communicated with the said cavity." (page 13, lines 21 – 22)

step c) is performed by mixing of said mixture with hot process stream being circulated in said work cavity, for a negligible time in comparison with the residence time, **(12)**

"In this process the reacting mixture is heated to pyrolysis temperature for negligible time in comparison with a duration of pyrolysis reactions due mixing with hot pyrolized gas being circulated in a working cavity of the blading reactor." (page 5, lines 13 – 16)

"The period of time for heating the incoming feed/steam mixture from the temperature when entering into the reactor up to pyrolysis temperature is defined by duration of mixing with reacting mixture being processed and does not exceed 0.001 sec. It is negligible short time in comparison with the residence time of reacting mixture within a working space of the reactor." (page 8, lines 8 – 12)

"… the said heating the mixture to the pyrolysis temperature is performed by mixing with hot pyrolized gas being circulated in a working cavity of the blading rotary reactor for a negligible time in comparison with a duration of pyrolysis reactions." (page 13, lines 9 – 11)

step d) is performed by using heat, generated directly in the process stream in result of hydrodynamic drag of said rotated work blades. **(13)**

"… heating resulting mixture to pyrolysis temperature in a blading rotary reactor by heat generated inside a volume of reacting mixture due to hydrodynamic drag of the rotor blades rotating therein;…" (page 5, lines 10 – 12)

"During every passing over the working blade the reacting fluid acquires an additional kinetic energy, which for the time before next passing is converted into a heat. This occurs partly due to passing the fluid through

stationary compression shocks arising in places of local transition of the fluid through sonic barrier, and partly due to vortex formation." (page 10, lines 20 – 23)

"... heating a resulting mixture to pyrolysis temperature in a blading rotary reactor by heat generated inside a volume of the mixture due to hydrodynamic drag of the rotor blades rotating therein,..." (page 13, lines 6 – 8)

Claim 10. The process of claim 9, wherein a gas-turbine engine is used as a drive of said reactor, and step b) is performed in two stages, and first stage of said preheating is carried out in first heat exchanger utilizing heat of exhaust gases of said gas-turbine engine, and (14)

"Preheating the feedstock and steam-diluent can be performed in two stages, ..." (page 5, line 17)

"... gas-turbine engine 5 connected with reactor 4 by shaft 6, and with the preheater 1 by exhaust pipe 7.

Preheating a feedstock and steam-diluent in the first stage is carried out in the preheater 1. The hydrocarbon feed from outside source (not shown in drawings) is conveyed by pressure into the preheater 1 configured as a shell-tube heat exchanger. The exhaust gas from the gas-turbine engine 5 is discharged into intertubular space of this heat exchanger. From outside source (not shown in drawings) a water is conveyed by pressure into the preheater 1 where the water is evaporated, and resulting steam-diluent is mixed with the hydrocarbon feed."(page 6, lines 25 – 32)

second stage of said preheating is carried out in second heat exchanger utilizing heat of hot product stream outgoing from said reactor. (15)

"Preheating the feedstock and steam-diluent can be performed in two stages, where the second stage is carried out in a heat exchanger by heat taken away from the cracked gas leaving the reactor." (page 5, lines 17 – 19)

"Preheating a feedstock and steam-diluent in the second stage is carried out in the apparatuses 2 and 3 for quenching cracked gas by utilisation of heat of cracked gas leaving the reactor." (page 6, lines 33 – 35)

"... and in the second stage the preheating is carried out in a heat exchanger by utilizing a heat contained in the cracked gas outgoing from the blading rotary reactor." (page 13, lines 13 – 15)